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(54) Title of the Invention: Etching Endpoint Monitoring Method and Apparatus

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Specification

1. Title of the Invention: Etching Endpoint Monitoring Method and Apparatus
2. Scope of Patent Claims

1) In monitoring an etching endpoint during the course of etching a metallic thin film that has been formed on the surface of a semiconductor substrate,
an etching endpoint monitoring method wherein infrared light with a wavelength greater than 1.2 μm and less than 2 μm is caused to enter the surface of the semiconductor substrate on the side where the aforementioned metallic thin film has not been formed on the surface of the aforementioned semiconductor substrate, the intensity of the light that has permeated into the aforementioned semiconductor substrate entered the aforementioned metallic thin film surface is measured, and the etching endpoint is determined from the intensity of its reflected light.

2) In monitoring an etching endpoint during the course of etching a metallic thin film that has been formed on the surface of a semiconductor substrate,
an etching endpoint monitoring method wherein infrared light with a wavelength greater than 1.2 μm and less than 2 μm is caused to enter the surface of the semiconductor substrate on the side where the aforementioned metallic thin film has not been formed on the surface of the aforementioned semiconductor substrate, the intensity of the light that has permeated into the aforementioned semiconductor substrate entered the aforementioned metallic thin film surface is measured, and the intensity of the light from the aforementioned semiconductor substrate is compared to the intensity of the light that has permeated the aforementioned semiconductor substrate.

3) An etching endpoint monitoring apparatus wherein are installed
a means to generate infrared light,
a half mirror that will cause the light that is generated to be transmitted,

a vacuum chamber in which plasma is used to perform the etching on the semiconductor substrate,

a lower electrode that is provided in the said vacuum chamber, has a through hole, and is placed onto the aforementioned semiconductor substrate,

an upper electrode that has been provided opposite to the aforementioned lower electrode in the said vacuum chamber,

a light guiding means that is attached to the through hole of the aforementioned lower electrode to conduct transmitted light from the aforementioned half mirror to the aforementioned semiconductor substrate,

and a light receiving means to receive the reflected light from the metallic thin film formed on the aforementioned semiconductor substrate from the aforementioned light guiding means through the aforementioned half mirror.

4) An etching endpoint monitoring apparatus wherein are installed:

a means to generate infrared light,

a half mirror that causes the infrared light it has emitted to be transmitted,

a vacuum chamber in which plasma is used to perform the etching of the semiconductor substrate,

a lower electrode that is provided in the said vacuum chamber, has a through hole, and is placed onto the aforementioned semiconductor substrate,

an upper electrode that that been provided opposite to the aforementioned lower electrode in the said vacuum chamber, and that has a through hole that is placed opposite to the through hole of the aforementioned lower electrode,

a first light guiding means that is attached to the through hole of the aforementioned lower electrode to conduct transmitted light from the aforementioned half mirror to the aforementioned semiconductor substrate,

a first light receiving means to receive the reflected light from the metallic thin film formed on the aforementioned semiconductor substrate from the aforementioned light guiding means through the aforementioned half mirror,

a second light guiding means that is attached to the through hole of the aforementioned upper electrode to receive transmitted light from the aforementioned metallic thin film,

a second light receiving means to receive light from the said second light guiding means,

and a means to compare the reflected light output from the aforementioned first light receiving means to the transmitted light output from the aforementioned second light receiving means and determine an etching endpoint from their compared outputs.

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3. Detailed Explanation of the Invention

[Industrial Field of the Invention]

The present invention relates to an etching endpoint monitoring method and apparatus in the etching process for metallic thin films that are essential in the fabrication process of all manner of devices.

[Prior Art]

Knowing precisely the endpoint in the etching of metallic thin films that are essential in the fabrication processes for all manner of devices is extremely important in obtaining fine patterns with good precision. A number of proposals have been made to date. Among these, we have shown the most realistic methods and means in Table 1.

Method	Means
Optical Method	Visual changes in color. Changes in reflectance. Ellipsometry.
Spectroscopic Analysis	Emission spectrometry, absorption spectrometery. Raman spectroscopy. Fluorescent spectroscopy.
Gas Spectrometry	Mass spectroscopy. Gas chromatography

Optical methods include those methods of observation that rely on the human senses, such as the visual observation from the window of a vacuum chamber during etching and projecting laser light from the window of a

vacuum chamber onto a surface that is being etched, methods for detecting changes in reflected light or methods of detecting changes in the reflectance using an ellipsometer.

Methods that use laser light project the light from outside the window in a vacuum chamber and then similarly detect from outside the window. One disadvantage is that the substance being etched eventually will adhere to the window, reducing the detection capacity. Additionally, there were problems with the detection position or SN ratio when attempting detection at a distance from the sample.

Spectroscopic analysis and gas spectrometry use spectrometry or gas spectrometry to detect substances that have been etched in a gaseous state. These are methods that define the end of etching as the point at which the substance undergoing etching can no longer be detected.

Like the optical methods described above, the disadvantages to these methods involve the loss of detection capacity as substances adhere to the window because detection is attempted from outside a window in the vacuum chamber. Additionally, even when the etching is complete, the substance being etched remains as a residue inside the vacuum chamber for some time, which causes the problem of detecting the end of etching later than it actually occurred.

[Problems that the Invention is to Solve]

The object of the present invention is to provide an etching endpoint monitoring method and apparatus that will resolve the various disadvantages including the inability to obtain a satisfactory SN ratio, difficulties in detection positioning caused by attempts to detect at a distance from the sample, and the loss of detection capacity caused by contamination of the window in the vacuum chamber due to adhesion of the etched substances.

Means of Solving the Problems

In order to achieve this objective, the present invention introduces optical fiber into a vacuum chamber, where it is placed onto an electrode plate to which a high voltage will be applied in order to generate plasma. Infrared light of greater than 1.2 μm will be projected that will pass through the Si from the rear surface of the Si substrate upon which the metallic thin film has been etched and the reflection from the surface of the metallic thin film or the transmitted light and the reflected light will be used to monitor the etching endpoint.

To be more specific, in the first embodiment of the present invention, as we monitor the etching endpoint when etching a metallic thin film onto the surface of a semiconductor substrate, we project infrared light with a wavelength of greater than 1.2 μm but less than 2 μm or less onto the surface of the semiconductor substrate on the side of the semiconductor substrate where no metallic thin film has been formed. We measure the intensity of the infrared light that passes through the semiconductor substrate that is reflected by the metallic thin film surface and calculate the etching endpoint based on that reflected intensity.

In the second embodiment of the present invention, as we monitor the etching end point while etching a metallic thin film onto the surface of a semiconductor substrate, we project an infrared light with a wavelength of greater than 1.2 μm but less than 2 μm onto the surface of the semiconductor substrate on the side where no metallic thin film has been formed. We measure the intensity of the infrared light that passes through the semiconductor substrate and which is reflected by the metallic thin film surface and that of the light that passes through the metallic thin film, and compare the intensity of the light reflected from the semiconductor substrate with the intensity of the light that passes through the semiconductor substrate.

The third embodiment of the present invention is characterized in that it is equipped with a means to generate infrared light, a half-mirror that can allow infrared light that is received to pass through, a vacuum chamber for etching onto semiconductor substrates using plasma, a through hole in the vacuum chamber, a lower electrode where the semiconductor substrate is placed and, in the vacuum chamber, an upper electrode, which is placed in opposition to the lower electrode, a first optical fiber that is embedded in the hole in the lower electrode to conduct the transmitted light from the half-mirror to the semiconductor substrate as well as a means to receive light from the light guiding means through the half-mirror from the metallic thin film formed on a semiconductor substrate.

The fourth embodiment of the present invention is characterized in that it is equipped with a means to generate infrared light, a half-mirror that allows the infrared light that is generated to pass through, a vacuum chamber in which etching is performed on the semiconductor substrates using plasma, a lower electrode upon which the semiconductor substrate is placed that has a through hole in the vacuum chamber, an upper electrode that has a through hole opposite to the hole in the lower electrode and is placed opposite to the lower electrode in the vacuum chamber, a first light guiding means that is embedded in the hole in the lower electrode to conduct the light that passes through the half-mirror to the semiconductor substrate, a first light receiving means to receive the reflected light from the metallic thin film formed on the semiconductor substrate through the half-mirror from the first means of guiding light, a second light guiding means to receive the transmitted light from the metallic oxide film and is embedded in the through hole in the upper electrode, a second light receiving means to receive light from the first

light guiding means, and a means for determining the etching endpoint by comparing the reflected light output from the first light receiving means with the transmitted light output from the second light receiving means.

[Effect]

In the present invention, light is projected from an extremely close point of contact with the rear surface of the Si substrate. The reflected light will be detected, so it will be a simple matter to position the detection module and obtain an excellent SN ratio. There will also be no effect from contamination by etched substances.

[Embodiments]

We will explain below the embodiments of the present invention in detailed and specific terms on the basis of the drawings.

Embodiment 1

FIG. 1 is a diagram that explains the first embodiment of the present invention, where 1 denotes the optical fiber, 2 is the optical fiber vacuum intake port, 3 is the rod lens, 4 is the half-mirror, 5 is the infrared light emitter, 6 is the infrared light detector, 7 is the window in the vacuum chamber, 8 is the upper electrode, 9 is the vacuum chamber, 10 is the Si substrate, 11 is the lower electrode and 12 is the plasma generating RF power supply. Optical fiber 1 leads into vacuum chamber 9 through port 2 and on to the through hole in lower electrode 11. Rod lens 3 is inserted into this through hole and when silicon substrate 10 is placed on lower electrode 11, the tip of this rod lens is placed in contact with the lower surface of the substrate.

In order to operate this device, infrared light from infrared light emitter 5 with a wavelength of 1.3 μm that has been modulated to a 1 KHz sine wave is passed through half-mirror 4 and into optical fiber 1. Rod lens 3 produces parallel light and projects it at silicon substrate 10, where the metallic thin film has been formed. The portion of the infrared light with a wavelength of 1.3 μm is reflected by the rear surface of silicon substrate 10 and received, but part of it passes through the inside of the Si, where it is reflected by the metallic thin film surface and passes through rod lens 3 a second time, returning to optical fiber 1. The infrared light that comes back to optical fiber 1 is reflected by half-mirror 4 and detected by infrared light detector 6.

When a metallic film is etched using plasma and then removed, reflected light from the metallic thin film disappears, so the endpoint of the etching can be determined.

Figure 2 shows the results of the measurements using the apparatus of this embodiment. As shown in Figure 2, a more accurate etching endpoint can be determined than when using the results of the spectroscopic analysis.

Embodiment 2

Figure 3 is a diagram that explains the second embodiment of the present invention, where 1(a) and 1(b) are optical fiber, 3(a) and 3(b) are rod lenses, 6(a) and 6(b) are infrared detectors and 13 is a computing device. Rod lenses 3(a) and 3(b) are connected to electrodes 10 and 8 respectively and then are joined to optical fibers 1(a) and 1(b). The light from optical fibers 1(a) and 1(b) is conducted into infrared detectors 6(a) and 6(b).

In this embodiment, just as in Embodiment 1, infrared light with a wavelength of 1.3 μm is conducted into vacuum chamber 9 using optical fiber 1(a) and is projected from the rear surface of Si substrate 10 where the metallic thin film is being formed. This reflected light is detected by infrared light detector 6(a). In addition to this, there is a through hole in upper electrode 8 and rod lens 3(b) and optical fiber 1(b) are arranged to fit the optical axis of the transmitted light from below. When the metallic thin film is removed through etching, the transmitted light that is generated is received and transmitted to detector 6(b). As described above, the reflected light output detected by detectors 6(a) and 6(b) and the transmitted light output are entered into computation device 13. Here, by comparing the intensity of the transmitted light to the intensity of the reflected light, a clearly defined etching endpoint can be determined.

Figure 4 shows the results of the measurements of the etching endpoints determined using this embodiment. As we can see from Figure 4, this embodiment shows etching endpoint is clearly obtained.

Moreover, silicon substrates were used in the examples in the embodiments described above, but the present invention is not limited to silicon substrates, and could be applied effectively to any semiconductor substrate to which metallic thin films were to be affixed. In that instance, the values for infrared light wavelength that could penetrate semiconductor substrates like these would, for example, naturally be in the 1.2 to 2μm range.

Additionally, we used optical fiber in the above embodiments as the means for conducting the light, but the means for conducting light is not limited solely to this. Lenses or other optical systems or optical light guides could also be combined.

[Effect of the Invention]

As described above, this invention introduces optical fiber into a vacuum chamber and introduces light from the rear surface of the substrate surface where the metallic thin film has been formed through etching. We saw to it that the light from the reflective surface of the metallic thin film was, for the most part, detected, so the advantages

include the following: The positioning of the detection module is easy, the SN ratio is excellent and the substances to be etched are not affected by contamination.

4. Brief Explanation of the Drawings

Figure 1 is a schematic diagram showing the first embodiment of the present invention.
Figure 2 is a characteristics diagram showing the results of the measurements with the first embodiment.
Figure 3 is a configuration diagram showing the second embodiment of the present invention.
Figure 4 is a characteristics diagram showing the results of the measurements using the second embodiment.

1	Optical fiber
2	Optical fiber vacuum port
3	Rod lenses
4	Half-mirror
5	Infrared light generator
6	Infrared light detector
7	Vacuum chamber window
8	Upper electrode
9	Vacuum chamber
10	Si substrate
11	Lower electrode
12	RF power supply
13	Computing unit

[see source for diagram]

7 Window
3 Rod lens
8 Upper electrode
4 Half mirror
1 Optical fiber
9 Vacuum chamber
5 Infrared detector
2 Optical fiber vacuum port
10 Si substrate
11 Lower electrode
RF power supply
6 Infrared detector

Configuration Diagram for the Embodiments of this Invention

Figure 1

[see source for diagram]

Etching Endpoint
Conventional Spectroscopic Analysis
Current Invention
Arbitrary Guide
Etching Time (seconds)

Figure 2

[see source for diagram]

1(b) Optical Fiber
Rod lens 3(b)
Rod lens 3(a)
6(b) Infrared detector
13 Computing unit
6(a) Infrared detector
1(a) Optical Fiber

Configuration Diagram of Embodiment of the present Invention

Figure 3

[see source for diagram]

Etching Endpoint

Output from computer
(transmitted light /reflected light)

Reflected light

Arbitrary Guide

Transmitted light

Etching Time (seconds
Characteristics Diagram of Embodiment of the present Invention

Figure 4

METHOD AND APPARATUS FOR MONITORING ETCHING END POINT

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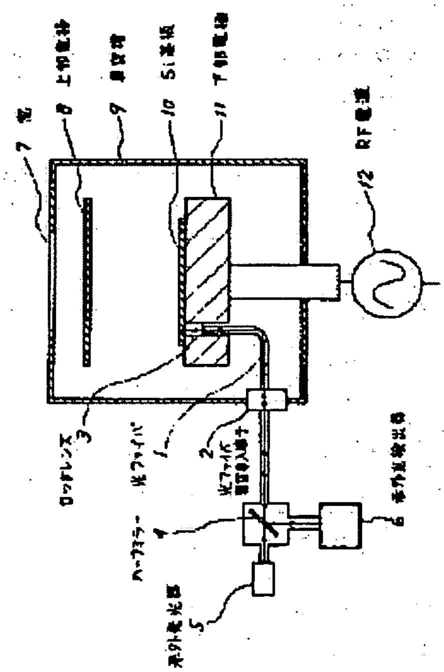
Abstract of **JP62190728**

PURPOSE:To eliminate the influence of contamination of a substance to be etched by introducing an infrared light of a predetermined wavelength to the surface of a semiconductor substrate of the side not formed with a thin metal film of the surface of the substrate, measuring the intensity of the light reflected on the thin film through the substrate of the infrared light, and obtaining the etching end point by the intensity of the reflected light to readily position a detector, thereby improving S/N ratio.

CONSTITUTION:The infrared light of 1.3mum of wavelength modulated by a sinusoidal wave of 1kHz from an infrared light emitting unit 5 is passed through a half mirror 4 to an optical fiber 1, and emitted to a silicon substrate 10 formed with the thin metal film as parallel beam via a rod lens 3. Part of the infrared light of 1.3mum of wavelength is reflected on the back surface of the substrate 10, but is passed through the Si, reflected on the metal film surface, again through the lens 3, and returned to the optical fiber 1. The returned infrared light is reflected on the half mirror 4, and detected by an infrared light detector 6. When the metal film is etched and removed by the plasma, the reflected light is erased from the metal film, thereby notifying the etching end point.



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⑭発明の名称　エッチング終点モニタ法および装置

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明　細　書

1．発明の名称

エッチング終点モニタ法および装置

2．特許請求の範囲

1)半導体基板表面に形成された金属薄膜をエッチングする際のエッチング終点をモニタするにあたり、

前記半導体基板の表面のうち、前記金属薄膜の形成されていない側の半導体基板表面へ、波長1.2μm以上2μm以下の赤外光を入射させ、該赤外光のうち、前記半導体基板中を透過して前記金属薄膜面で反射された光の強度を測定し、その反射光強度よりエッチング終点を求めることを特徴とするエッチング終点モニタ法。

2)半導体基板表面に形成された金属薄膜をエッチングする際のエッチング終点をモニタするにあたり、

前記半導体基板の表面のうち、前記金属薄膜の形成されていない側の半導体基板表面へ、波長1.2μm以上2μm以下の赤外光を入射させ、該赤外光のうち、前記半導体基板中を透過して前記金属薄膜面で反射された光および前記金属薄膜を透過した光の強度を測定し、前記半導体基板からの反射光の強度と前記半導体基板を透過した光の強度とを比較することを特徴とするエッチング終点モニタ法。

3)赤外光を発光する手段と、

その発光した赤外光を透過させるハーフミラーと、

プラズマを用いて半導体基板にエッチングを行う真空槽と、

該真空槽内に配設され、貫通孔を有し、かつ前記半導体基板を載置する下部電極と、

前記真空槽内に、前記下部電極と対向して配設された上部電極と、

前記下部電極の貫通孔に嵌着され、前記ハーフミラーからの透過光を前記半導体基板に導く光導波手段と、

前記半導体基板上に形成された金属薄膜からの反

射光を前記光導波手段から前記ハーフミラーを経て受光する受光手段と
を具えたことを特徴とするエッチング終点モニタ装置。

4)赤外光を発光する手段と、
その発光した赤外光を透過させるハーフミラーと、
プラズマを用いて半導体基板にエッチングを行う真空槽と、
該真空槽内に配設され、貫通孔を有し、かつ前記半導体基板を載置する下部電極と、
前記真空槽内に、前記下部電極と対向して配設され、かつ前記下部電極の貫通孔と対向した貫通孔を有する上部電極と、
前記下部電極の貫通孔に嵌着され、前記ハーフミラーからの透過光を前記半導体基板に導く第1光導波手段と、
前記半導体基板上に形成された金属薄膜からの反射光を前記光導波手段から前記ハーフミラーを経て受光する第1受光手段と、

前記上部電極の貫通孔に嵌着され、前記金属薄膜からの透過光を受ける第2光導波手段と、
該第2光導波手段からの光を受光する第2受光手段と、
前記第1受光手段からの反射光出力と、前記第2受光手段からの透過光出力とを比較し、その比較出力からエッチング終点を求める手段と
を具えたことを特徴とするエッチング終点モニタ装置。

（以下、余白）

3．発明の詳細な説明

〔産業上の利用分野〕

本発明は、各種デバイスの作製工程において必須の金属薄膜のエッチング工程中のエッチング終点をモニタする方法および装置に関するものである。

〔従来の技術〕

各種デバイスの作製工程において必須である金属薄膜のエッチングの終点をエッチング中に正確に知ることは、精度の良い微細パターンを得る上で極めて重要であり、これまでいくつかの提案がなされてきた。それらの中で実用的な方法および手段を第1表に示す。

第1表　エッチングの終点検出方法及び手段

方　法	手　段
光学的方法	目視による色の変化 反射率の変化 エリプソメトリー
分光分析法	発光分析、吸光分析 ラマン分光 蛍光分析
ガス分析法	質量分析 ガスクロマトグラフィ法

光学的方法としては、エッチング中に真空槽の窓から人間の目によって観察する方法で人間の感覚に頼る方法と、レーザ光を真空槽の窓からエッチングする面へ照射し、反射光の変化を検出する方法あるいはエリプソメータにより屈折率の変化を検出する方法がある。

レーザ光を用いる方法は、真空槽の窓の外から光を入射させ、同じく窓の外から検出するものであり、エッチングされた物質が窓に付着することにより、検出能力が低下する欠点を有していた。また、試料から離れた位置で検出するため、検出部の位置合せやSN比に問題を残していた。

分光分析法およびガス分析法は、いずれもエッチングされたガス状の物質を分光法あるいはガス分析法により検出し、エッチングされた物質が検出されなくなった時点をエッチングの終点とする方法である。

これらの欠点は、上記光学的方法と同様に、真空槽の窓の外から検出するので窓の付着物による検出能力の低下があることに加えて、エッチング

が終了してもエッチングされた物質はしばらく真空槽内に残留するため、実際のエッチング終点よりも遅れて検出されるという欠点を有していた。

〔発明が解決しようとする問題点〕

そこで、本発明の目的は、エッチング付着物による真空槽の窓の汚染により検出能力が低下すること、試料から離れた位置で検出することにより検出部の位置合せがむずかしいこと、良好なSN比がとれないことの諸欠点を解決したエッチング終点モニタ法および装置を提供することにある。

〔問題点を解決するための手段〕

このような目的を達成するために、本発明では、光ファイバを真空槽内に導入し、プラズマを発生させるための高電圧が印加される電極板の中へ設置し、エッチングされる金属薄膜が形成されているSi基板の裏面からSiを透過する 1.2μm 以上の赤外光を照射し、金属薄膜面からの反射あるいは透過光と反射光の比を用いてエッチングの終点をモニタする。

すなわち、本発明の第1形態は、半導体基板表面に形成された金属薄膜をエッチングする際のエッチング終点をモニタするにあたり、半導体基板の表面のうち、金属薄膜の形成されていない側の半導体基板表面へ、波長 1.2μm 以上2μm 以下の赤外光を入射させ、赤外光のうち半導体基板中を透過して金属薄膜面で反射された光の強度を測定し、その反射光強度よりエッチング終点を求めることを特徴とする。

本発明の第2形態は、半導体基板表面に形成された金属薄膜をエッチングする際のエッチング終点をモニタするにあたり、半導体基板の表面のうち、金属薄膜の形成されていない側の半導体基板表面へ、波長 1.2μm 以上2μm 以下の赤外光を入射させ、赤外光のうち、半導体基板中を透過して金属薄膜面で反射された光および金属薄膜を透過した光の強度を測定し、半導体基板からの反射光の強度と半導体基板を透過した光の強度とを比較することを特徴とする。

本発明の第3形態は、赤外光を発光する手段

と、その発光した赤外光を透過させるハーフミラーと、プラズマを用いて半導体基板にエッチングを行う真空槽と、真空槽内に配設され、貫通孔を有し、かつ半導体基板を載置する下部電極と、真空槽内に、下部電極と対向して配設された上部電極と、下部電極の貫通孔に嵌着され、ハーフミラーからの透過光を半導体基板に導く第1光ファイバと半導体基板上に形成された金属薄膜からの反射光を光導波手段からハーフミラーを経て受光する受光手段とを具えたことを特徴とする。

本発明の第4形態は、赤外光を発光する手段と、その発光した赤外光を透過させるハーフミラーと、プラズマを用いて半導体基板にエッチングを行う真空槽と、真空槽内に配設され、貫通孔を有し、かつ半導体基板を載置する下部電極と、真空槽内に、下部電極と対向して配設され、かつ下部電極の貫通孔と対向した貫通孔を有する上部電極と、下部電極の貫通孔に嵌着され、ハーフミラーからの透過光を半導体基板に導く第1光導波手段と半導体基板上に形成された金属薄膜からの反射光を第1光導波手段からハーフミラーを経て受光する第1受光手段と、上部電極の貫通孔に嵌着され、金属薄膜からの透過光を受ける第2光導波手段と、第2光導波手段からの光を受光する第2受光手段と、第1受光手段からの反射光出力と、第2受光手段からの透過光出力とを比較し、その比較出力からエッチング終点を求める手段とを具えたことを特徴とする。

〔作　用〕

本発明では、Si基板の裏面に接触した極めて近い位置から光を入射し、その反射光を検出するので検出部の位置合せが簡単なこと、良好なSN比がとれること、およびエッチングされる物質の汚染による影響を受けないこと。

〔実施例〕

以下に図面に基づいて本発明の実施例を詳細かつ具体的に説明する。

実施例1.

第1図は本発明の第1の実施例を説明する図で

あって、ここで、1は光ファイバ、2は光ファイバ真空導入端子、3はロッドレンズ、4はハーフミラー、5は赤外発光器、6は赤外光検出器、7は真空槽の窓、8は上部電極、9は真空槽、10はSi基板、11は下部電極、12はプラズマ発生用RF電源である。光ファイバ1はハーフミラー4から端子2を介して真空槽9内に導き、さらに下部電極11にあけた貫通孔に導く。この孔にはロッドレンズ3を挿入しておき、シリコン基板10を下部電極11上に載置したときにこのロッドレンズの先端が基板下面と当接するようにしておく。

この装置を動作するには、赤外発光器5から1KHzの正弦波に変調した波長 1.3μm の赤外光を、ハーフミラー4を透過させて、光ファイバ1に導入し、ロッドレンズ3により平行光として金属薄膜の形成されたシリコン基板10に照射する。波長 1.3μm の赤外光の一部はシリコン基板10の裏面で反射を受けるが一部はSiの内部を透過して金属薄膜面で反射し再びロッドレンズ3を通り、光ファイバ1へ戻る。光ファイバ1の中を戻ってきた赤外光はハーフミラー4で反射され赤外光検出器6で検出される。

プラズマにより金属薄膜がエッチングされて除去されると、金属薄膜からの反射光が消滅するため、エッチングの終点を知ることが可能となる。

第2図に本実施例の装置を用いた測定結果を示す。第2図からわかるように、分光分析の結果と比較して正確にエッチングの終点を知ることができる。

実施例2.

第3図は本発明の第2の実施例を説明する図であって、1(a),1(b) は光ファイバ、3(a),3(b) はロッドレンズ、6(a),6(b) は赤外光検出器、13は演算装置である。ロッドレンズ3(a)および3(b)を、それぞれ、電極10および8に取りつけ、さらに光ファイバ1(a)および1(b)に結合する。光ファイバ1(a)および1(b)からの光を赤外光検出器6(a)および6(b)にそれぞれ導く。

本例においても、実施例1と同様に、波長 1.3μm の赤外光を光ファイバ1(a)を用いて真空槽9に導入し、金属薄膜の形成されたSi基板10の裏面から照射し、その反射光を赤外光検出器6(a)で検出する。これとは別に、上部電極8に貫通孔を設け、ロッドレンズ3(b)および光ファイバ1(b)を下方から透過光の光軸に合せて配設して、金属薄膜がエッチングで除去された際に生じる透過光を受光し、検出器6(b)伝播する。以上のようにして検出器6(a)および6(b)でそれぞれ検出された反射光出力と透過光出力を演算装置13に入力し、ここで、透過光強度を反射光強度で除算することにより、明確なエッチングの終点を求める。

本実施例により求めたエッチング終点の測定結果を第4図に示す。第4図からわかるように、本例によれば、エッチングの終点出力が明確に得られる。

なお、上述した実施例では、シリコン基板を例にとったが、本発明はシリコン基板に限定されるものではなく、金属薄膜の付着したいかなる半導体基板に対しても有効に適用できる。その場合に、赤外光の波長はかかる半導体基板を透過できる値、たとえば 1.2～2μm にすることはもちろんである。

さらにまた、上例では、光を導く手段として光ファイバを用いたが、光導波手段はこれにのみ限られず、レンズなどの光学系や光導波路などを組合せ用いることもできる。

〔発明の効果〕

以上説明したように、本発明によれば、真空槽内に光ファイバを導入し、エッチングされる金属薄膜が形成されている基板面の裏面から光を導入し、金属薄膜の反射面からの光を主に検出するようにしたので、検出部の位置合せが容易なこと、SN比が良いこと、エッチングされる物質の汚染の影響を受けないことの利点がある。

4. 図面の簡単な説明

第1図は本発明の第1の実施例を示す構成図、

第2図は第1の実施例における測定結果を示す特性図、

第３図は本発明の第２の実施例を示す構成図、

第４図は第２の実施例の測定結果を示す特性図である。

1 … 光ファイバ、
2 … 光ファイバ真空導入端子、
3 … ロッドレンズ、
4 … ハーフミラー、
5 … 赤外発光器、
6 … 赤外検出器、
7 … 真空槽の窓、
8 … 上部電極、
9 … 真空槽、
10 … Si基板、
11 … 下部電極、
12 … RF電源、
13 … 演算器。

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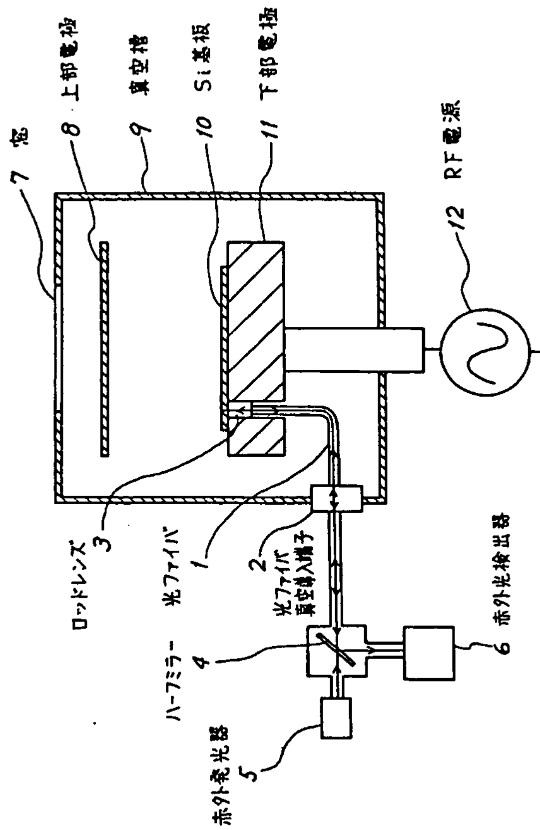
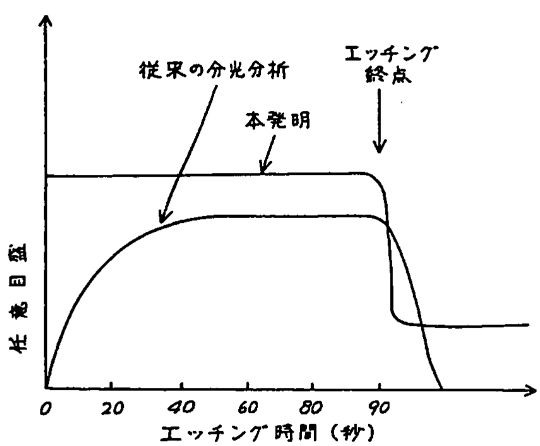


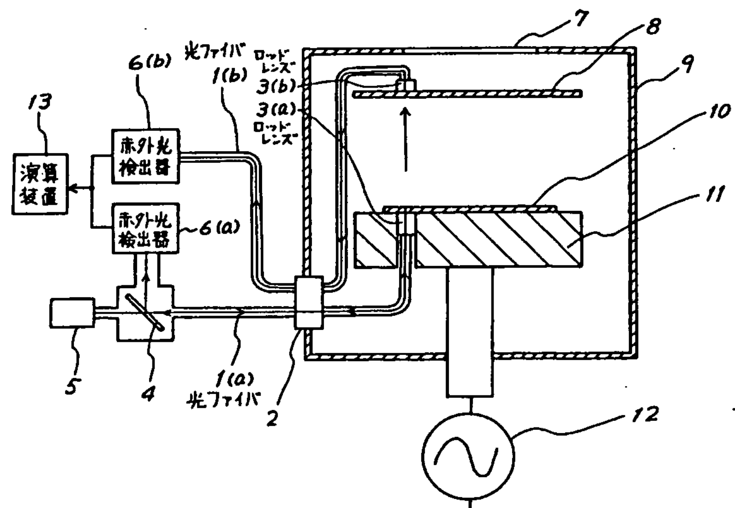
本発明実施例の構成図

第１図



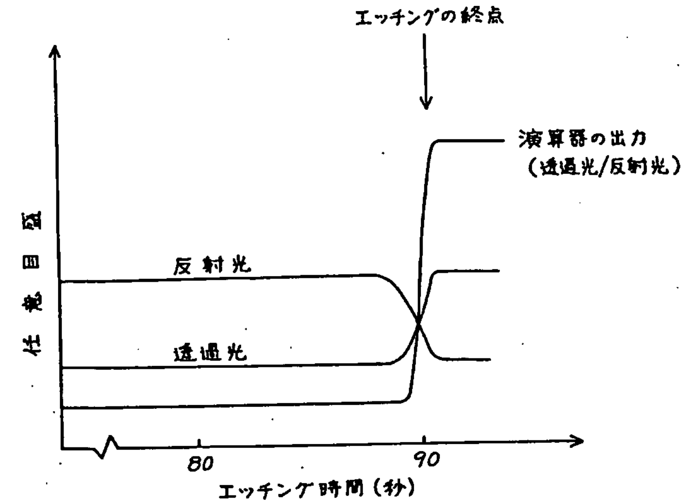
測定結果を示す特性図

第２図



本発明実施例の構成図

第３図



本発明実施例の特性図

第 4 図